Tropical Pacific Proving Ground (TPPG) for GOES-R

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School of Ocean and Earth Science and Technology (SOEST)
University of Hawaii at Manoa

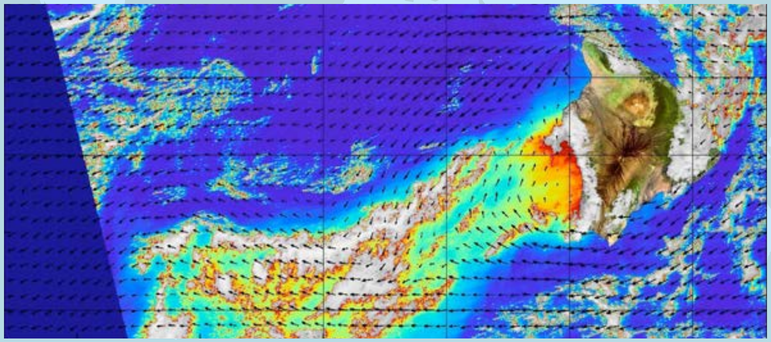


Image by John Porter

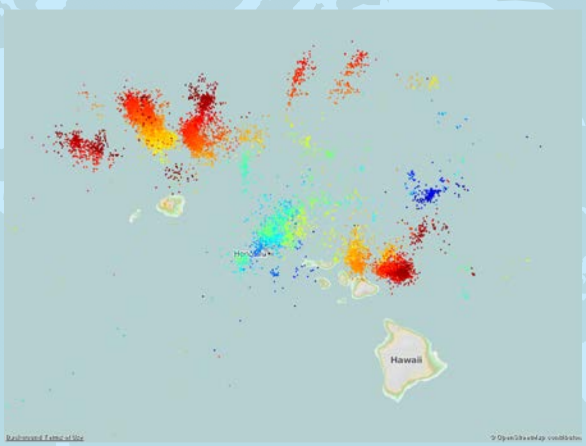
1

Outline

- Lightning detection and rainfall proxy
- Vog observation and prediction
- Atmospheric Rivers, Tsunamis and GPS
- Hurricane force winds in winter storms - data loss and data assimilation problem

2

Pseudo Reflectivity Product



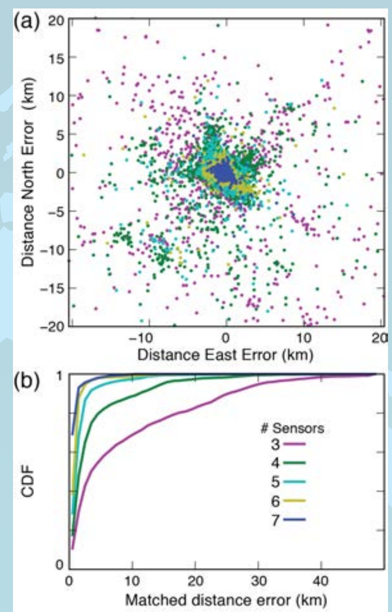
Convective lightning in tropical storm Wali from 04 to 20 UTC (blue-red) on 20 July 2014. *Stolz, Businger and Terpstra JGR 2014*

3

GLD360 Continuing to Improve

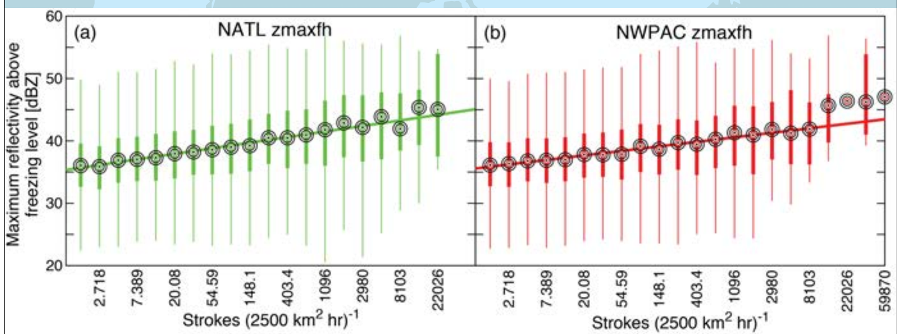
- New sensors in the Pacific
- Better calibration
- New processing algorithms

Lead to better location accuracy and detection efficiency



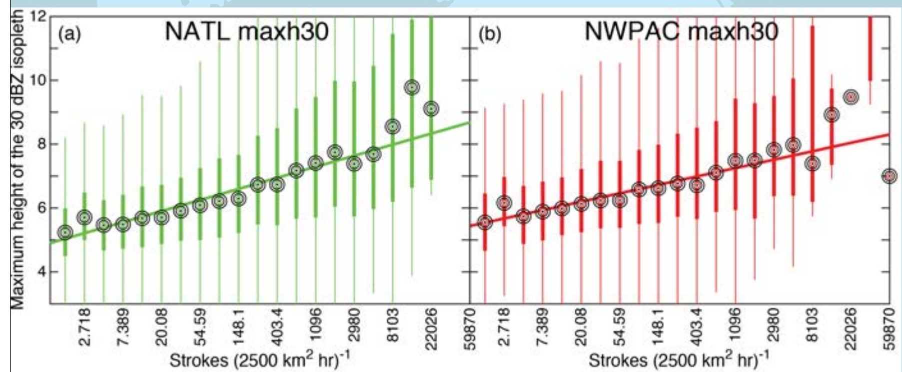
4

Lightning Rate vs Max Reflectivity above the Freezing Level



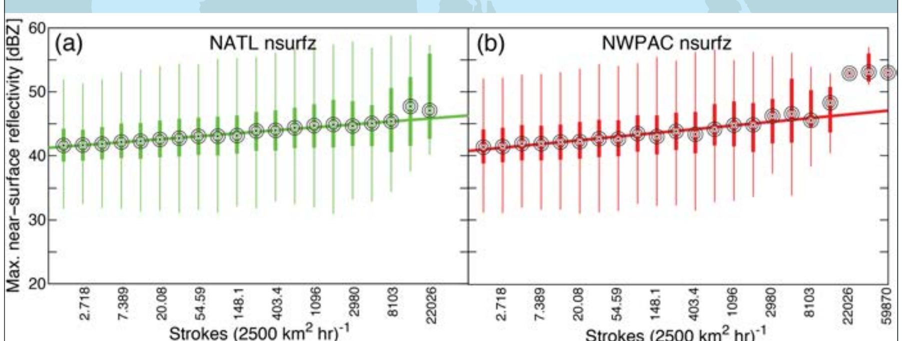
5

Lightning Rate vs Max Height of the 30 dBz Isopleth



6

Lightning Rate vs Near-surface Reflectivity



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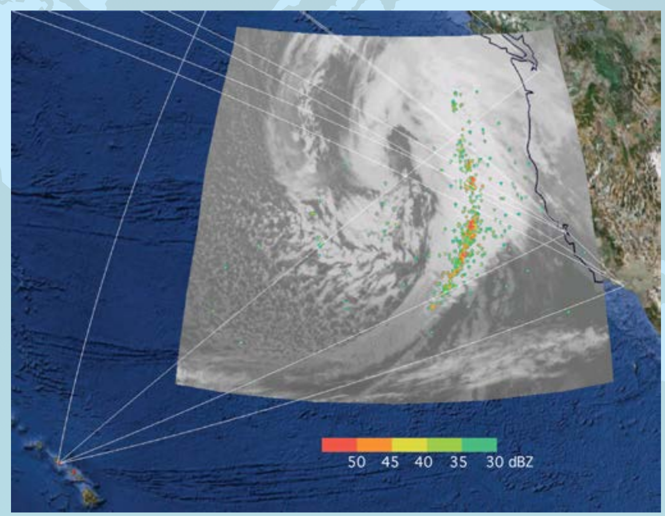
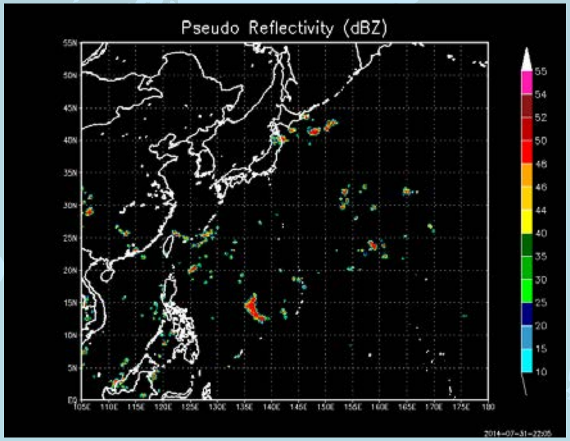
Pseudo Reflectivity Product



8

Pseudo Reflectivity Product

Has been ported to AWIPS II with help from Roy Huff and Eric Lau.



Observing and Predicting Vog Dispersion from Hawai‘i’s Kīlauea Volcano

Two Kilauea Vents

Halema`uma`u Crater vent is part of the Kilauea summit crater.

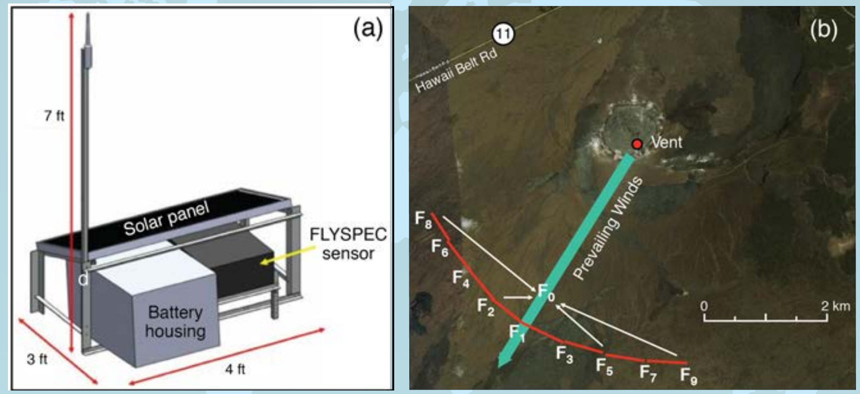
Pu’u’O’o vent is part of the east rift zone

Volcanic emissions are greatest where the lava first reaches the surface.

Proximity of Hazard to Volcano Village

Effects Felt far Downstream

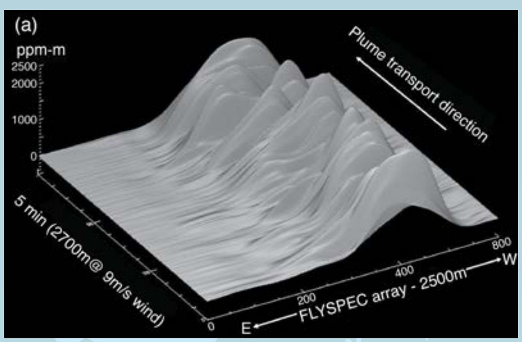
Flyspec Array



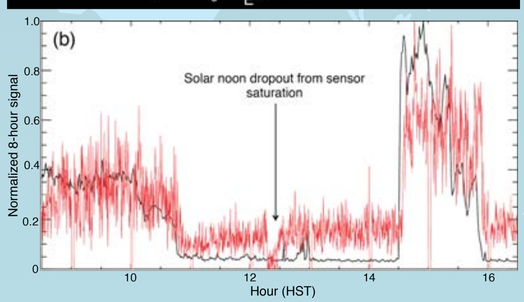
An array of 10 flyspecs continuously monitors the Halemaumau plume under prevailing NW tradewind conditions.

Plume SO_2 Structure

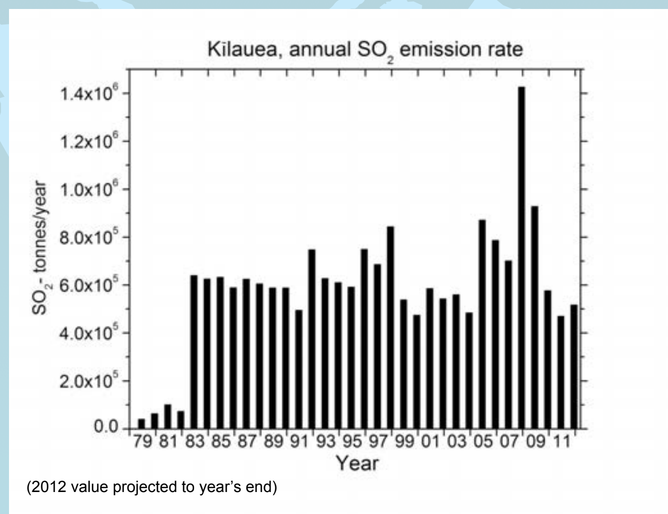
Plume SO_2 structure measured by the FLYSPEC array for a single 5-minute period.

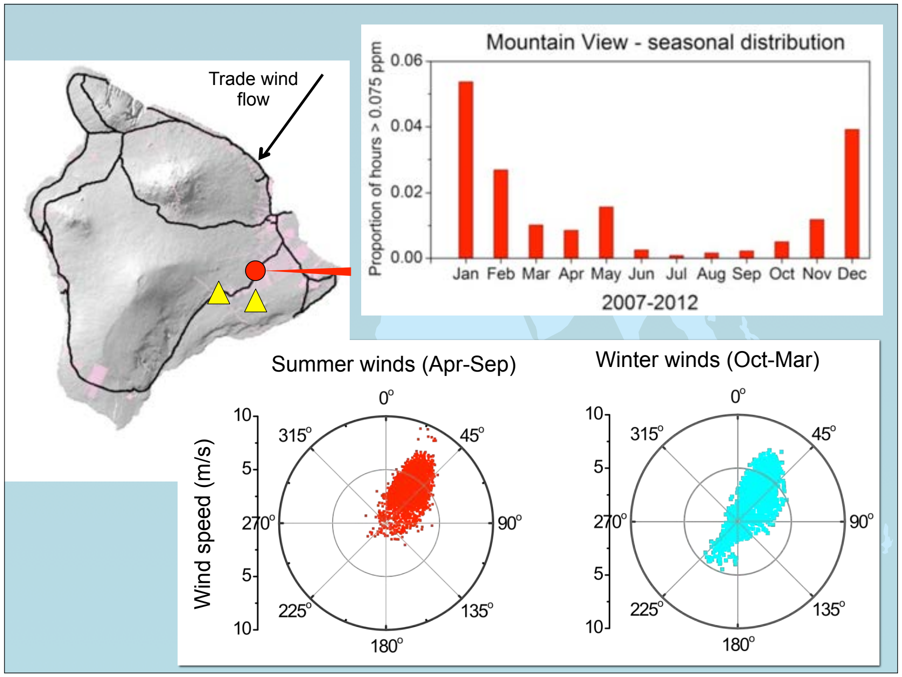


Plot of 10-m Real-time Seismic Amplitude Monitoring (RSAM) seismic signal (black) for 15 August 2012, with 10-s array SO2 emission rate (red), both normalized to their maximum values



Kilauea SO_2 Emission Rates





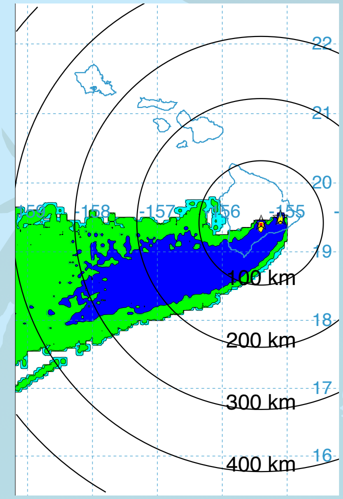
Vog Model is a Custom Application of the HySPLIT Model

Hybrid Single Particle Lagrangian Integrated Trajectory Model

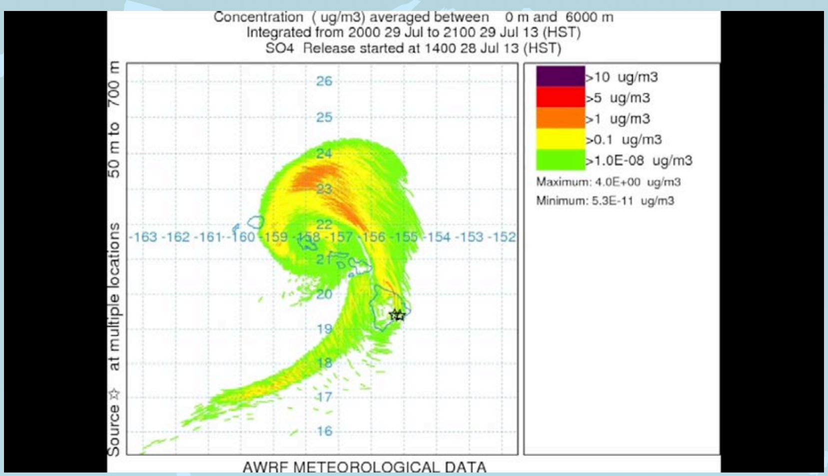
Developed by Roland Draxler (et al.) at NOAA-ARL

Components:

- Trajectory Simulation
  - Time integrated advection
- Dispersion
  - Vertical diffusivity profile and wind shear
  - Horizontal deformation of the wind field
- Pollutant Concentrations
  - Particles: Cell-averaged
  - Puffs: Calculated at a specific grid point
- Nested grid



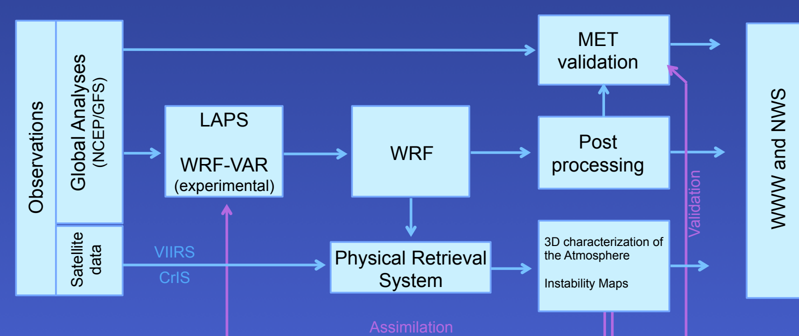
Input for Vog Model



- Weekly Averaged SO_2 emissions from HVO for the summit and East Rift Zone.
- Meteorological Fields from the Weather Research and Forecast (WRF) model.

DB Based Nowcasting System

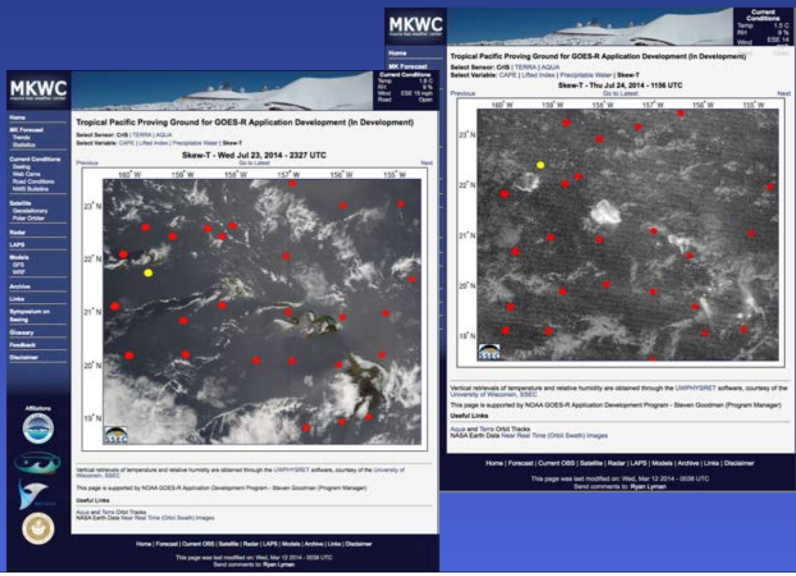
- Since August 2013, an operational custom nowcasting system which combines the use of high resolution IR satellite data, VIIRS images, and the WRF model forecasts, is available on the MKWC web pages.



- *Cherubini, T. and S. Businger, JAMC 2012*

DB based Nowcasting System

http://mkwc.ifa.hawaii.edu/satellite/polar/



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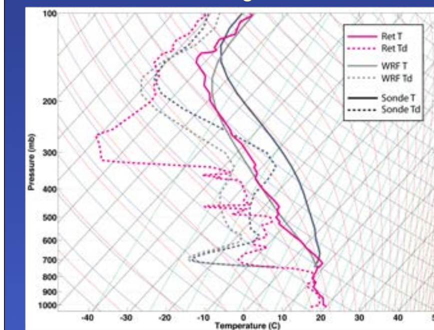
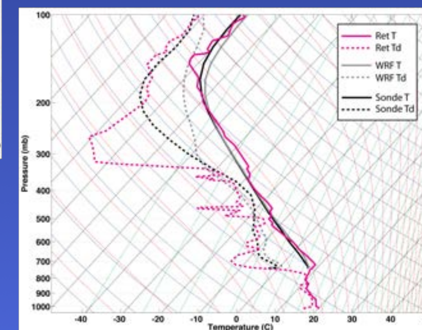
Improvements to Physical Retrieval - MIRTO

UHPHYSRET on high elevation FOVs



MIRTO on high elevation FOVs



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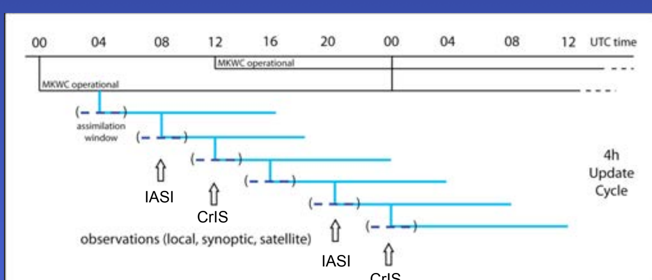
Future Work and Developments

- All the ingredients exist to implement a Rapid Update Cycle system:
  - A local mesoscale modelling system (WRF-ARW);
  - Real time satellite data;
  - Assimilation tools (WRF-VAR/3DVAR);



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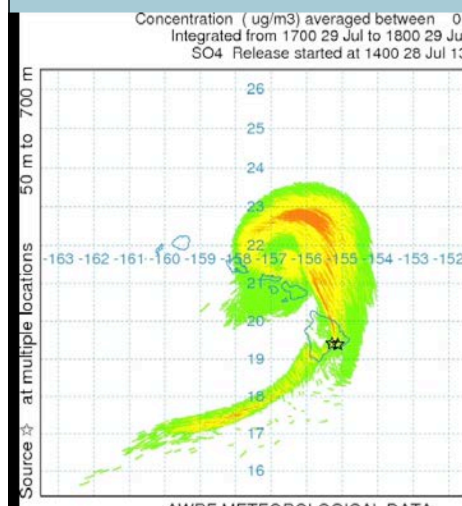
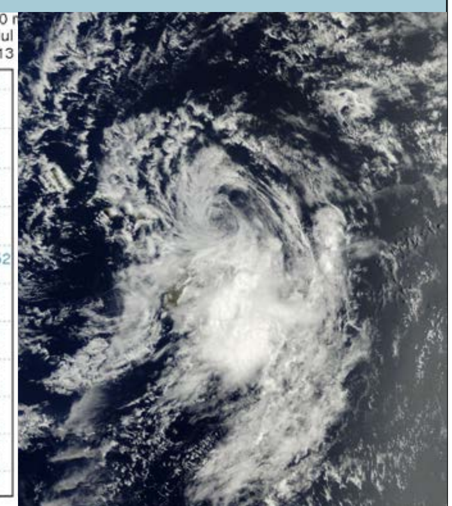
Case Study: Tropical Storm Flossie





Vog model layer-averaged SO_4 concentration (left) and VIIRS true color image of tropical cyclone Flossie. *Pattantyus and Businger GRL 2014*

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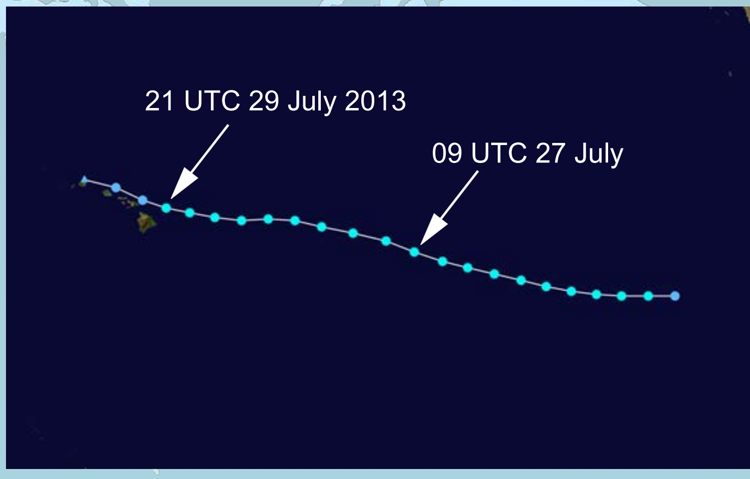
Tropical Storm Flossie Track



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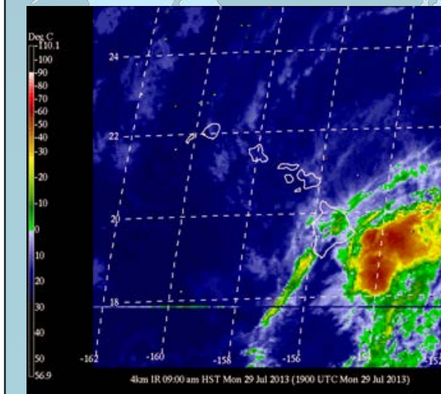
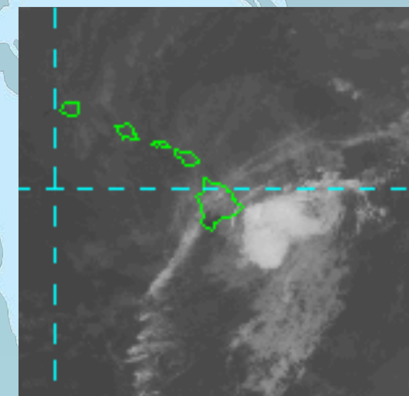
GOES-IR Observations
No Lightning Prior to Vog Entrainment





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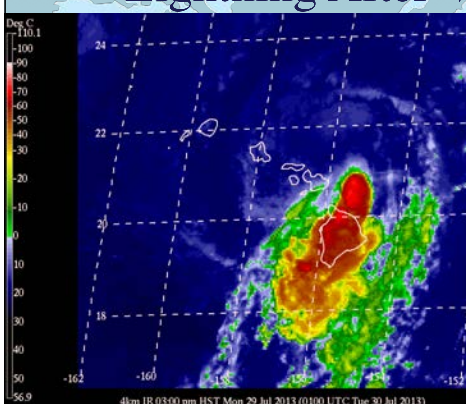
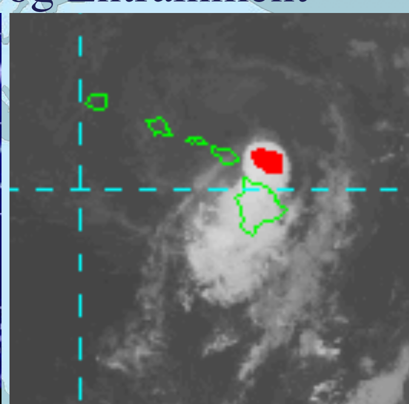
GOES-IR Observations
Lightning After Vog Entrainment





Lightning observed when vog aerosols were first predicted to be present in convection. Sulfate aerosols CCN reduce cloud drop sizes that help promote charge separation and lightning.

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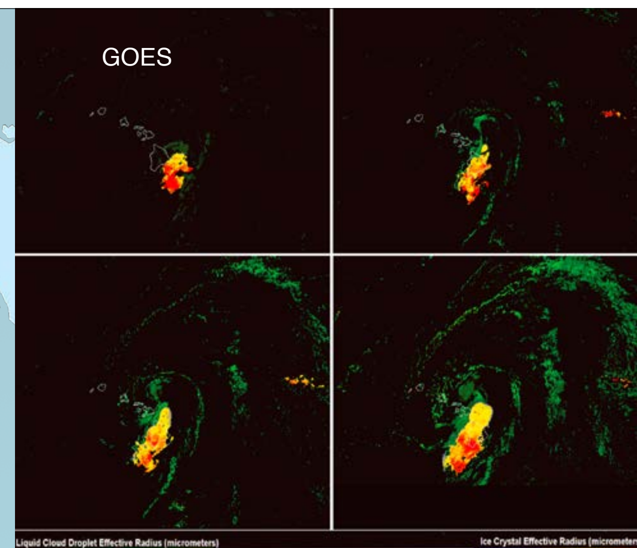

Effective ice and liquid droplet radius (μm) retrievals from GOES-West valid (a) 2100 UTC and (b) 2200 UTC 29 July 2013 and (c) 0000 UTC, (d) 0100 UTC 30 July 2013. Ice particles are shown in the rainbow scale. Liquid particles are shown in the green scale.

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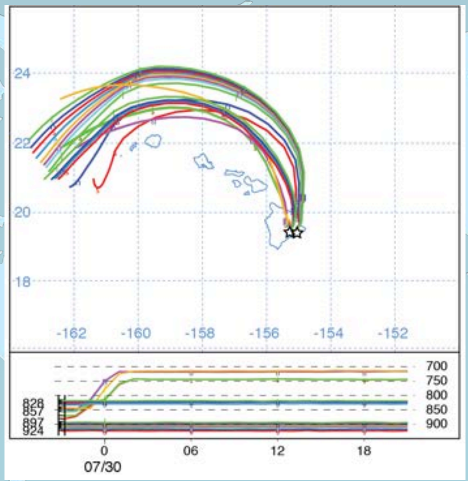
Vog Model – Particle Trajectories



Single particle trajectories show transport from source locations.

20 locations: 10 for each plume from 50 m AGL to 700 m AGL.

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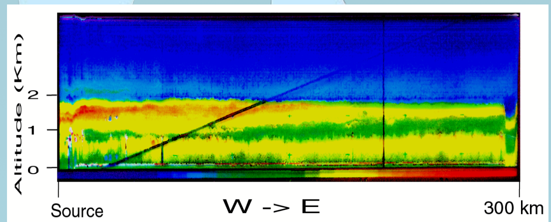
New and Future Developments

- Include 3-dimensional field of LWC from WRF to improve simulation of conversion of SO_2 to SO_4.
- Plume-height algorithm to improve model initial conditions.
- Ensemble vog forecasts.
- Use satellite data to estimate existing SO_2 and SO_4 concentrations to improve initial condition of the model.
- Validate model using in-situ and satellite observations.



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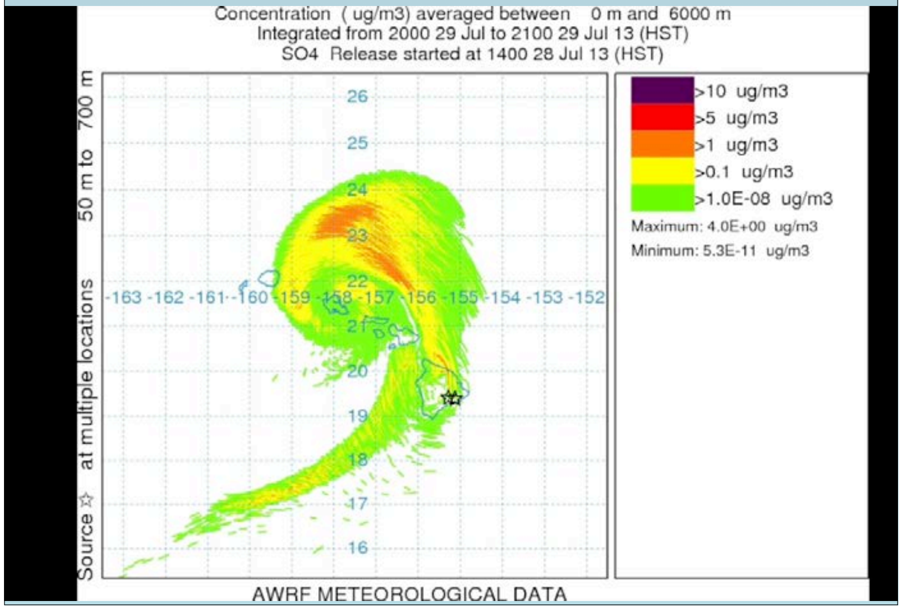
Questions?



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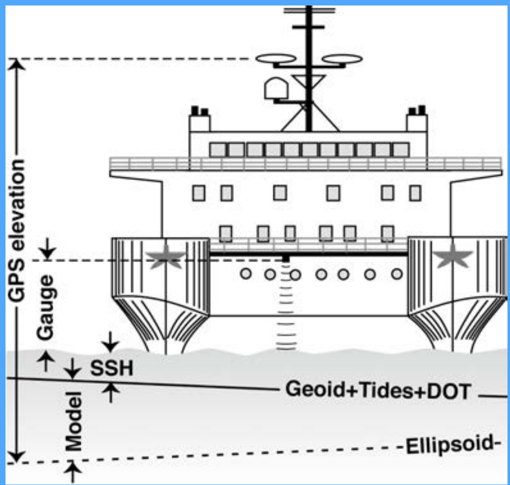
Detecting Tsunamis with Ships



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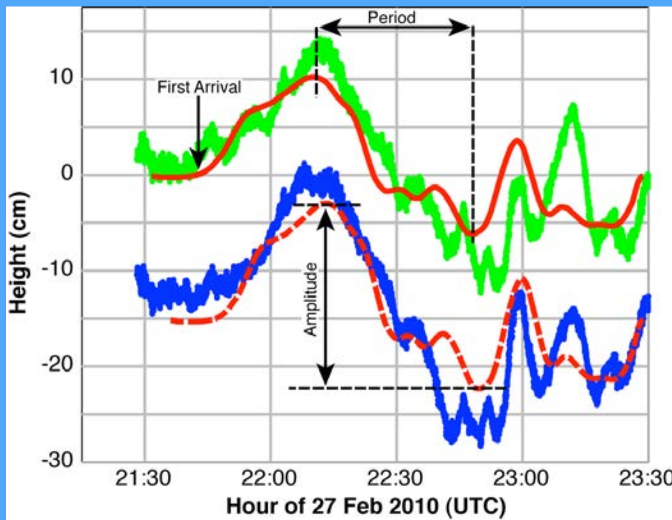
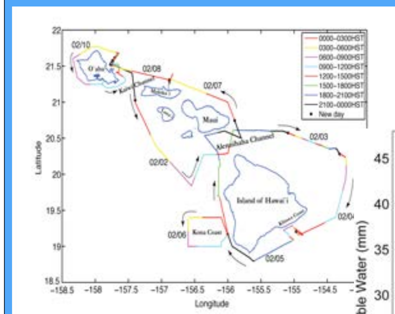
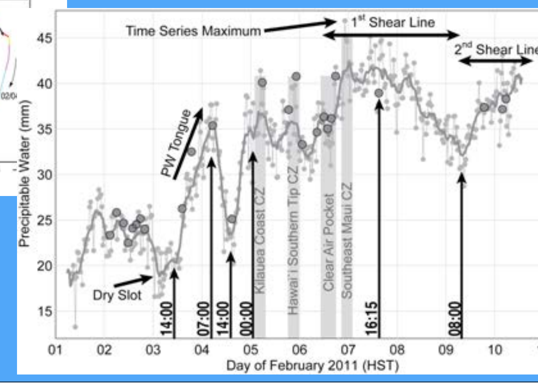
The 27 Feb 2010 Chile Tsunami



10-day cruise captured synoptic and mesoscale PW features

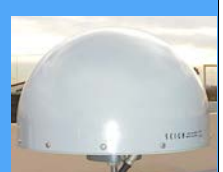


Kealy, Foster, and Businger, JGR 2012

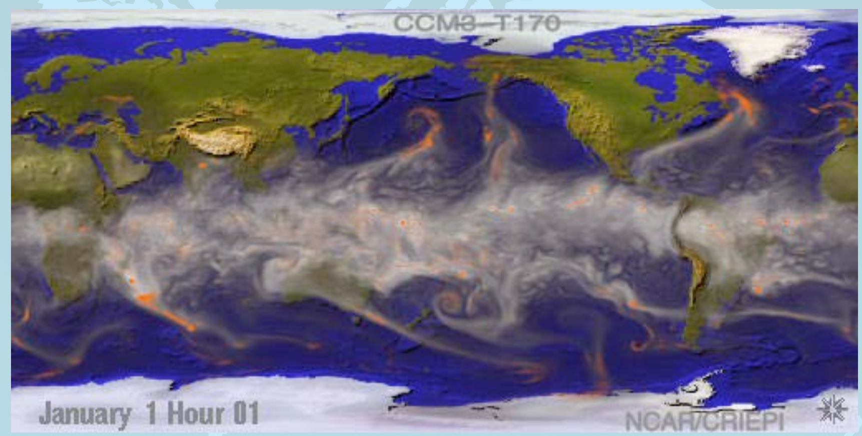


Requirements

- Need to install GPS and miniVSAT/ Iridium antenna with good sky-view, and a pressure/temperature sensor (radar gauge?)
- Need (inside?) space to house GPS receiver and miniVSAT/Iridium terminal and cable run
- Ship's AC power

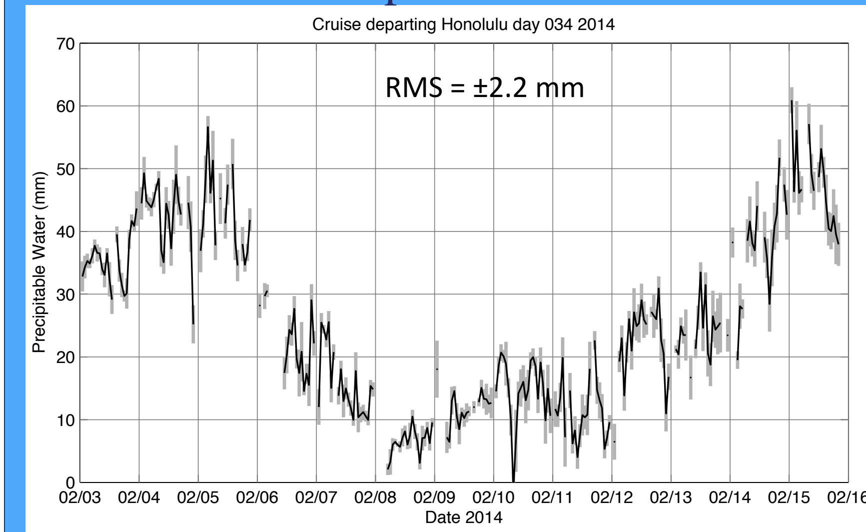


Atmospheric Rivers



Water Vapor is shown in white and precipitation in orange.

Atmospheric Rivers



14 Day Ship-based GPS Precipitable Water Time Series

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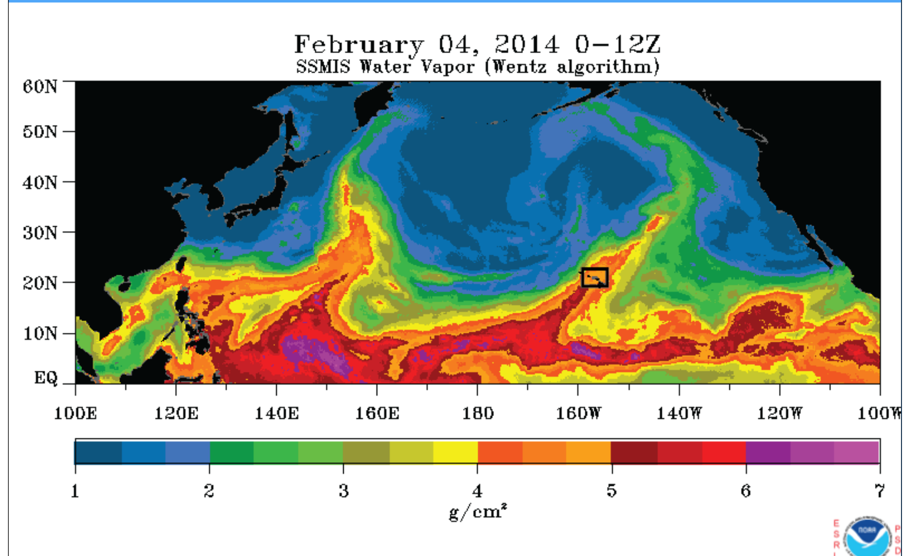

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Lost at Sea: Hurricane Force Wind Fields and the North Pacific Ocean Environment

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Lost at Sea

- One large ship sinks every week on average worldwide.
- Severe weather has sunk more than 200 supertankers and container ships exceeding 200 meters in length during the last two decades.
- ~10,000 large containers are lost at sea each year.

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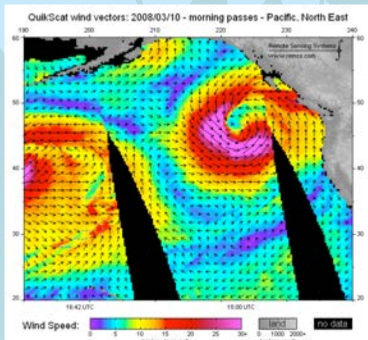
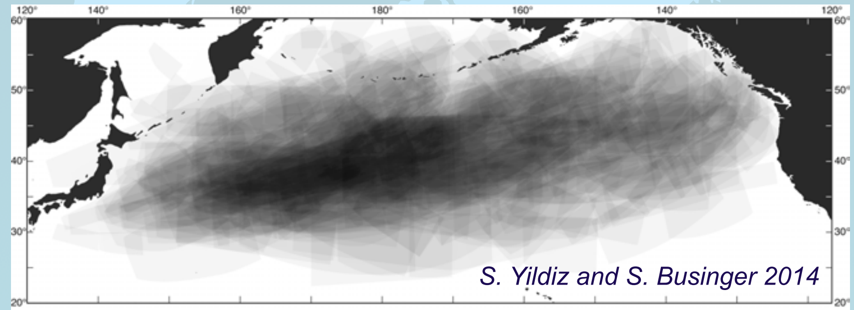
QuikSCAT

- QuikSCAT was launched in 1999 and failed in November 2009. Instrument sends microwave pulse, backscatter observation estimates wind speed through surface roughness. Data has ~25 km resolution.
- QuikSCAT can measure wind speeds up to 30 m s^{-1} (near hurricance force) with an accuracy of ±2 m s^{-1} (Shirtliffe, 1999). OPC forecasters routinely observe QuikSCAT winds in excess of 32.9 m s^{-1}.

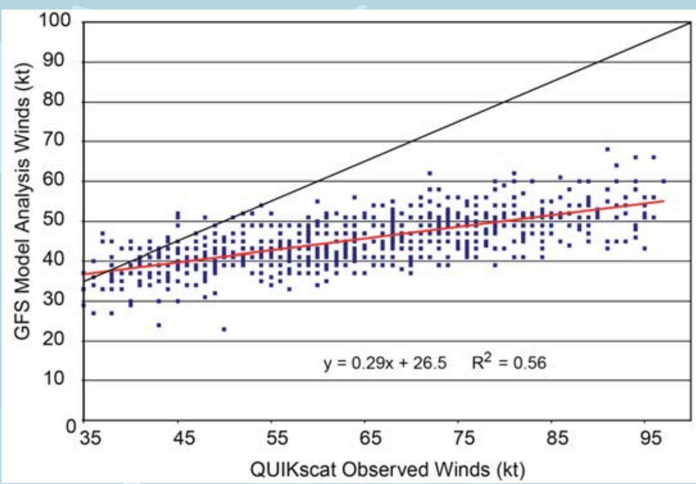


Hurricane Force Fetch Climatology

Jan 2003 through May 2008

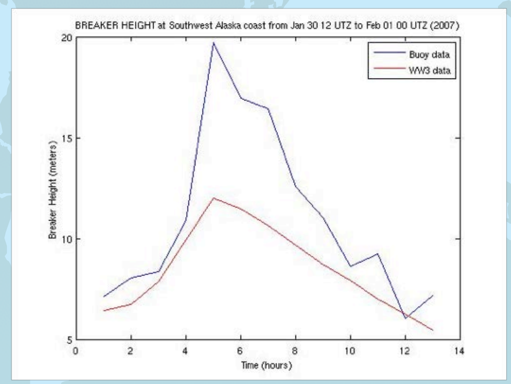


QuikSCAT Winds vs GFS Analyses



Comparison of 833 pairs of storm maximum winds observed by QuikSCAT and in the GFS initial analyses.

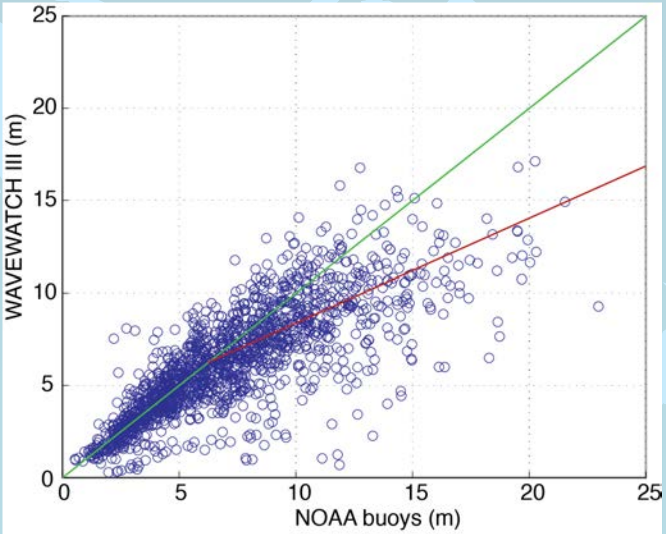
Comparison of WWIII Predicted vs Observed Breaker Heights: 1/30/2007



Breaker height = wave height x period x shoaling factor

Wave steepness reached .07 along the AK coast.

Breaker Height: Model v. Observations



Questions?